3.5 Energy

3.5.1 Regulatory Requirements and Methods of Evaluation

A. REGULATORY REQUIREMENTS

Federal Regulations

Federal Energy Regulatory Commission

The Federal Energy Regulatory Commission (FERC) is an independent agency that regulates the interstate transmission of natural gas, oil, and electricity. FERC also regulates natural gas and hydropower projects. As part of that responsibility, FERC regulates the transmission and sale of natural gas for resale in interstate commerce, the transmission of oil by pipeline in interstate commerce, and the transmission and wholesale sales of electricity in interstate commerce. FERC also licenses and inspects private, municipal, and state hydroelectric projects; approves the siting of and abandonment of interstate natural gas facilities, including pipelines, storage, and liquefied natural gas; oversees environmental matters related to natural gas and hydroelectricity projects and major electricity policy initiatives; and administers accounting and financial reporting regulations and conduct of regulated companies.

Corporate Average Fuel Economy Standards

Corporate Average Fuel Economy (CAFE) standards are federal regulations that are set to reduce energy consumed by on-road motor vehicles. The standards specify minimum fuel consumption efficiency standards for new automobiles sold in the United States. The current standard for passenger cars is 27.5 mpg (11.69 kilometers per liter [kpl]). The 1998 standard for light trucks was 20.7 mpg (8.8 kpl). On March 31, 2003, the National Highway Traffic Safety Administration, part of the U.S. DOT, issued new light truck standards for model-year 2005 of 21.0 mpg (8.93 kpl), 21.6 mpg (9.18 kpl) for model-year 2006, and 22.2 mpg (9.44 kpl) for model-year 2007 (National Highway Traffic Safety Administration 2006).

Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users

On August 10, 2005, the President signed into law SAFETEA-LU. SAFETEA-LU represents the largest surface transportation investment in history. The two acts that preceded this—the ISTEA and TEA-21—shaped the highway program to meet the country's changing transportation needs. SAFETEA-LU builds on these, supplying the funds and refining the programmatic framework for investments needed to maintain and grow the transportation infrastructure.

SAFETEA-LU addresses challenges such as improving safety, reducing traffic congestion, improving efficiency in freight movement, increasing intermodal connectivity, and protecting the environment. SAFETEA-LU promotes more efficient and effective transportation programs by focusing on transportation issues of national significance, while giving state and local transportation decision makers more flexibility for solving transportation problems in their communities (National Highway Traffic Safety Administration 2004).

Section 403(b) of the Power Plant and Industrial Fuel Use Act of 1978 (P.L. 95-620)

This section of the Power Plant and Industrial Fuel Use Act encourages conservation of petroleum and natural gas by recipients of federal financial assistance.

Executive Order 12185, Conservation of Petroleum and Natural Gas (December 17, 1979, 44 F.R. § 75093)

This executive order encourages additional conservation of petroleum and natural gas by recipients of federal financial assistance.

State Regulations

Public Resources Code Section 21100(b)(3) provides that an EIR shall include a statement setting forth the mitigation measures proposed to minimize the significant effects on the environment, including measures to reduce the wasteful, inefficient, and unnecessary consumption of energy. Appendix F to the CEQA Guidelines addresses energy conservation goals, notes that potentially significant energy implications of a project should be considered in an EIR, and contains general examples of mitigation measures for a project's potentially significant energy impacts.

CEQA Guidelines Section 15126.2 discusses requirements for an EIR to address potentially significant effects, and, although it does not include energy specifically, it mentions use of nonrenewable resources. CEQA Guidelines Section 15126.4(a)(1)(C) requires an EIR to discuss energy conservation measures, if relevant.

California Code of Regulations, Title 24, Part 6, Energy Efficiency Standards

Title 24, Part 6 of the California Code of Regulations, Energy Efficiency Standards, promotes efficient energy use in new buildings constructed in California. The standards regulate energy consumed for heating, cooling, ventilation, water heating, and lighting. The standards are enforced through the local building permit process. These standards may apply to any buildings (e.g., stations) constructed as part of or in association with the No Project and HST Alignment Alternatives[1].

B. METHOD OF EVALUATION OF IMPACTS

This evaluation of energy supply and demand compares potential energy use for intercity travel related to the HST and No Project Alternatives. This section explains the methodology used to evaluate the potential energy impacts and benefits attributable to operation (direct energy) and construction (indirect energy) of the alternatives under study. This section also explains the criteria used to determine whether a potential impact on energy consumption would be significant. The evaluation is based on available data and forecasts.

Direct Energy

The analysis of transportation energy focuses on the overall energy consumption differences between the No Project Alternative and a representative HST Alternative[2]. This approach captures the major transportation fuel inputs: petroleum oil and natural gas (a large component of electricity production). Electricity consumption as a specific item is also analyzed because of the special nature of electricity, specifically its nonstorability and its lack of suitability for trading in futures markets. The HST system would directly consume electricity, which the energy analysis focuses on, although natural gas is also addressed as one variable in the overall ability of the state's electricity-generating infrastructure to deliver adequate power to users. Moreover, total reserves of in-the-ground natural gas is relatively certain; while it is the market conditions and production capacity trends that principally determine the price and supply of this commodity, just as is the case for the other major transportation fuel, petroleum oil.

The energy analysis was performed as described below to determine the operational impact of the alternatives on overall regional transportation-related energy supply[3] and regional electricity supply during peak demand.

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[1] See Section 3.0, Introduction, for an explanation of how this section fits together with the HST Network Alternatives presented in Chapter 7, as well as for an overview of the information presented in the other chapters.

[2] Based on revised low-end ridership forecast developed by Cambridge Systematics June 11, 2007. Also refer to Chapter 2, "Alternatives," and Section 2.3.3.C, Travel Demand and Ridership Forecasts.

[3] *Overall energy* refers to the combination of energy derived from petroleum fuels and electrical energy.

Overall Statewide Transportation-Related Energy Supply

Overall direct energy consumption by the alternatives involves potential energy use for vehicle (automobiles, airplanes, and HSTs) operation and related infrastructure in the region. The potential direct impacts on overall transportation-related energy supply were evaluated both quantitatively and qualitatively.

The quantitative analysis focused on the direct relationship between projected vehicle miles traveled (VMT) (vehicle kilometers traveled [VKT]) and energy consumption to estimate the potential change in total energy consumption between the No Project Alternative and the HST Alternative. The quantitative assessment of direct energy impacts considered the VMT (VKT) for automobiles and HST, as described below (consistent with the analysis conducted for air quality).

Variation of Fuel Consumption Rates by Vehicle Type

For this analysis, the design demand was established based on the ridership studies conducted by the MTC, as discussed in Chapter 2, "Alternatives." Automobile VMT (VKT) modeling for the proposed HST system was developed as part of this Program EIS/EIR and used to develop VMT (VKT) values for existing conditions and the No Project Alternative.

The VMT (VKT) fuel consumption method used herein is outlined in *Technical Guidance*, Section 5309 New Starts Criteria (Federal Transit Authority, Office of Planning 1999). Energy consumption factors for the first two modes identified in Table 3.5-1 were developed by Oak Ridge Laboratory and published in the 2006 *Transportation Energy Book* (edition 25) (U.S. Department of Energy, Office of Planning, Budget Formulation and Analysis, Energy Efficiency and Renewable Energy 2006). These results are based on national averages for road, traffic, and weather conditions and are intended for general comparisons. The energy consumption factor for the HST mode is based on energy used by similarly designed trains, such as the Trains à Grande Vitesse in France and the Intercity Express in Germany (DE Consult 2000). This report assumes a 16-car trainset (engines and cars) with a 1,200-passenger carrying capacity.

Table 3.5-1
Direct Energy Consumption Factors

Mode	Factor (Btus/VMT)
Passenger vehicles (auto, van, light truck)[a]	5,572
Airplanes[a]	326,894
High-speed trains[b]	924,384

Btus = British thermal units.

Sources:
[a] U.S. Department of Energy, Office of Planning, Budget Formulation and Analysis, Energy Efficiency and Renewable Energy 2006; based on nationally averaged conditions and fleet composition.
[b] DE Consult 2000, based on a 16-vehicle trainset.

Overall direct energy, measured in Btus, was converted to equivalent barrels of crude oil to represent potential energy impacts and/or savings. (Btus are the standard units used by industry and government literature for such comparisons. Metric units for energy [i.e., Joules] are not used in this report.) Annual direct-energy consumption values for intercity travel was calculated and compared for existing conditions, the No Project Alternative, and the HST Alternative. The potential change in direct energy consumption from the future No Project condition (in Btus) was calculated for the HST Alternative.

The qualitative analysis of overall direct energy consumption considers the estimated or assumed levels of service for each of the alternatives and the effect that each would have on congestion and travel speeds, which would have a substantial impact on fuel efficiency and, therefore, energy use.

In addition to the overall direct energy analysis, average energy consumption per passenger mile (kilometer) was calculated for the HST Alternative.

Statewide Electricity Supply during Period of Peak Demand

For the HST Alternative, peak-period electricity demand was determined using an energy consumption factor for HSTs obtained from the *DE Consult Peer Review Report* (DE Consult 2000) and the operation plan developed as part of this Program EIR/EIS process. The demand was calculated in terms of megawatts (MW) and compared to current estimates of peak demand and supply capacity in the grid controlled by the California Independent System Operator (Cal-ISO). Peak demand for electricity for the future No Project Alternative is discussed qualitatively because it is not possible to measure at the program level. This approach is reasonable because the possible increase in transportation-related electricity use associated with these alternatives would likely be small and considered insignificant.

<u>Indirect Energy</u>

The energy that would be used to construct the proposed project is called indirect energy. Projected construction-related energy consumption refers to energy used for the construction of HST trackway and support facilities and transportation of materials and equipment to and from the work site. To the extent that construction energy information was available from other sources or existing HST systems, it was used in this analysis. However, some other countries have developed HST systems incrementally over extended periods of time (e.g., France) and have only limited relevant information available. Construction-related energy consumption factors identified for the proposed HST system included data gathered for typical heavy rail systems and a heavy rail commuter system, San Francisco Bay Area Rapid Transit District (BART). These data were used to estimate the projected construction-related energy consumption of the proposed HST system. Projected construction-related energy consumption is presented in Table 3.5-2. These estimates are appropriate for comparison purposes.

The construction energy payback period measures the number of years that would be required to pay back the energy used in construction with operational energy consumption savings. The payback period is calculated for this section by dividing the estimate of each alternative's construction energy by the amount of energy that would later be saved by the HST Alternative compared to the No Project condition. It is assumed that the amount of energy saved in the study year (2030) would remain constant throughout the payback period.

Table 3.5-2
Construction-Related Energy Consumption Factors for the Proposed HST System

Facility	Rural Compared to Urban[d]	Factor (billions of Btus)
At grade	Rural[b]	12.29/one-way guideway mi
	Urban[c]	19.11/one-way guideway mi
Elevated	Rural[b]	55.46/one-way guideway mi
	Urban[c]	55.63/one-way guideway mi
Below grade (cut)	Rural[b]	117.07/one-way guideway mi
	Urban[c]	163.14/one-way guideway mi
Below grade (tunnel)	Rural[b]	117.07/one-way guideway mi

Facility	Rural Compared to Urban[d]	Factor (billions of Btus)
	Urban[c]	328.33/one-way guideway mi
Station	N/A[e]	78[a]/station

[a] Value for construction of freight terminal. Used as proxy for HST station consumption factors.
[b] Estimates reflect typical rail system construction energy consumption.
[c] Estimates reflect energy consumption for BART system construction as surrogate for HST construction through urban area.
[d] Differences between the construction-related energy consumption factors for urban and rural settings reflect differences in construction methods, demolition requirements, utility accommodation, etc.
[e] Discreet (i.e., non-alignment-related facilities) are not differentiated between rural or urban because the data used to develop the respective values were not differentiated as such. Some difference between the actual values might be expected.

Sources: U.S. Congress, Budget Office 1977; U.S. Congress, Budget Office 1982; and California State Department of Transportation 1983; based on construction for air freight services.

C. CEQA SIGNIFICANCE CRITERIA

According to Appendix F of the CEQA Guidelines, the means to achieve the goal of conserving energy include decreasing overall per capita energy consumption, decreasing reliance on natural gas and oil, and increasing reliance on renewable energy sources. The significance criteria discussed herein are used to determine whether the alternatives would have a potentially significant effect on energy use, including energy conservation.

Significant long-term operational or direct energy impacts would occur if the HST Alternative would place a substantial demand on regional energy supply or require significant additional capacity, or significantly increase peak and base period electricity demand.

Significant short-term construction energy impacts would occur if construction of the HST Alternative were judged likely to consume nonrenewable energy resources in a wasteful, inefficient, or unnecessary manner.

A significant adverse cumulative effect would occur if implementation of the HST Alternative, together with regional growth, would contribute to a collectively significant shortage of regional or statewide energy (see Section 3.17, "Cumulative Impacts," and Chapter 5, "Economic Growth and Related Impacts").

By contrast, if the proposed project resulted in energy savings, alleviated demand on energy resources, or encouraged the use of efficient transportation alternatives, it would have a beneficial effect.

3.5.2 Affected Environment

A. STUDY AREA DEFINED

The study area for energy use was identified to be the state of California, the same as the travel demand forecasts prepared by Cambridge Systematics for the MTC. This differs from the statewide program EIR/EIS (California High Speed Rail Authority and Federal Railroad Administration 2005), where the study area was six of the air quality basins traversed by the statewide HST preferred alternative (the air basins used were identified because the majority of intercity trips taken in California occur within them).

At this program level of analysis, the area studied to determine the potential impacts of the proposed HST system on electricity generation and transmission was the entire state of California because most of this infrastructure in the state contributes to the statewide grid. Therefore this analysis cannot apportion to the study area the use of any particular generation facilities. In general, any potential impacts on electrical production that may result from the proposed HST system would affect statewide electricity reserves and, to a lesser degree, transmission capacity. Some general discussion of potential effects on regional electricity production and transmission is included.

B. GENERAL DISCUSSION OF ENERGY RESOURCES

California is the tenth largest worldwide energy consumer and is ranked second in consumption in the United States, behind Texas. Of the overall energy consumed in the state, the transportation sector represents the largest proportion at 46%. The industrial sector follows at 31%, residential at 13%, and commercial at 10%. Petroleum satisfies 54% of California's energy demand, natural gas 33%, and electricity 13%. Coal fuel accounts for less than 1% of total energy demand in California. Electric power and natural gas in California are generally consumed by stationary users, whereas petroleum consumption is generally accounted for by transportation-related energy use (California Energy Commission 2002). A description of the existing energy resources and market conditions that could be potentially affected by the proposed alternatives is provided below.

<u>Petroleum</u>

Demand for transportation services (and, therefore, petroleum/gasoline) in California mirrors the growth of the state's population and economic output. The California Energy Commission (CEC) records of historical trends coupled with current population and economic growth and gasoline price projections were used to estimate that on-road miles traveled are anticipated to increase by 41% between 2003 and 2025—from 314 billion to 446 billion[4]. Notwithstanding this large increase, the CEC predicts that instate road transportation fuel will remain steady at about 15 billion gallons per year. Although on-road gasoline demand is projected to be flat over the next 20 years, on-road diesel demand is projected to increase by 78%, from 2.7 billion gallons in 2003 to 4.8 billion gallons in 2025. Jet fuel usage is projected to increase 100%, from about 3 billion gallons in 2003 to just less than 6 billion gallons in 2025. (California Energy Commission 2005a.)

<u>Electricity</u>

Electricity as energy is given detailed consideration in this analysis because of the projected use of electric energy to power the proposed HST system. Meeting electricity demand is primarily an operational issue for system operators—it is important in evaluating system reliability, determining congestion points on the electrical grid, and identifying potential areas where additional generation, transmission, and distribution facilities might be needed. This analysis is concerned with the adequacy of the generation and transmission infrastructure to accommodate the inclusion of the HST system in the state's electricity grid; distribution issues are not considered at this program level of analysis.

Electricity used to power the proposed HST system would be generated from within the entire state (i.e., not just by PG&E) and could be imported from outside the state. Therefore this analysis cannot apportion to the study area the use of any particular generation facilities. Issues related to electricity transmission are discussed below.

Existing Electricity Demand

Electricity demand is measured in two ways: consumption and peak demand. Electricity consumption is the amount of electricity—measured in gigawatt-hours[5] (GWh)—that consumers in the state use.

[4] These projections use the California Air Resource Board's 2004 California Greenhouse Gas standards, which require automakers to begin selling vehicles with reduced greenhouse gas emissions by model year 2009 (California Air Resources Board 2004).

[5] Electric energy is measured in watts (W): 1,000 watts is a kilowatt (kW), 1,000 kilowatts is a megawatt (MW), and 1,000 megawatts is a gigawatt (GW). Electric consumption over time is measured in kilowatt-hours (kWh), megawatt-hours (MWh), and gigawatt-hours (GWh).

According to the CEC, total statewide electricity consumption grew from 166,979 GWh in 1980 to 228,038 GWh in 1990, at an estimated annual growth rate of 3.2%. The 1990s saw a slowdown in demand growth because of an economic recession that lasted until the middle of the decade. The statewide electricity consumption in 1998 was 244,599 GWh, reflecting an annual growth rate of 0.9% between 1990 and 1998 (California Energy Commission 2006a). In 2005, statewide consumption was about 272,000 GWh.

In contrast to the concept of energy consumption, peak demand—measured in megawatts—is the amount of generation needed to keep electrons flowing in the electricity system at any given moment of peak demand, usually integrated over 1 hour. A single MW is enough power to meet the expected electricity needs of 1,000 typical California homes (California Energy Commission 2003). For comparison, 1 GW would be enough power for 1,000,000 typical homes. California's peak demand typically occurs on a day in August between 3 and 5 p.m. High temperatures lead to increased use of air conditioning, which in combination with industrial loads, commercial lighting, office equipment, and residential refrigeration, comprise the major consumers of electricity consumption in the peak-demand period in California (California Energy Commission 2000). In August 2006, according to CEC, peak electricity demand for California was expected to be 59,498 MW[6].

Existing Electricity Generation Capacity

In-state electricity generation, which accounted for 78% of the 2005 total electrical supply, is fueled by natural gas (38%); nuclear sources (14%); coal[7] (20%); large hydroelectric resources (20%); and renewable resources (11%), including wind, solar, and geothermal. Electricity imports in 2005 accounted for 22% of total production. (California Energy Commission 2006c.)

In-state generation capacity was expected to be about 56,697 MW in 2006, for a total net generation capacity of 71,095 MW, with the inclusion of 13,118 MW of imports. As noted above, peak demand in August 2006 was estimated to be 59,498 MW, indicating an operating reserve[8] margin of 18.5%[9] in an average temperature year. If 2006 had been a year of adverse conditions (i.e., one that had higher than average temperatures[10], high zonal transmission limitations, and high numbers of forced outages), the operating reserve margin would have been 7.4% without the advantage of demand response programs and interruptibles.[11] (California Energy Commission 2006d.)

For comparison's sake, Cal-ISO) declares a Stage 1 emergency when operating reserve margins fall below 7%; Stage 2 and 3 emergencies are declared when shortfalls of more than 5% and 1.5%, respectively, are imminent[12] (California Energy Commission 2004a).

Existing Transmission Capacity

Electricity transmission capacity refers to the maximum amount of power that can be carried from the generating source to the utility provider and is a key component in the electrical power delivery system. Transmission capacity affects the:

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[6] Estimated. Based on average summer temperatures.

[7] Intermontane and Mohave coal plants are considered to be in-state facilities because they are in Cal-ISO-controlled areas.

[8] Operating Reserve - That capability above firm system demand required to provide for regulation, load forecasting error, equipment-forced and scheduled outages, and local area protection. It consists of spinning reserve and nonspinning reserve.

[9] (Operating Generation - Imports with Reserves)/(Demand - Imports with Reserves)

[10] In this case, high temperatures that have a 10% chance of occurring in any one year.

[11] Customers reducing their electricity consumption in response to either price or system reliability events, and customers being paid for performance based on wholesale market prices.

[12] A Stage 1 declaration serves as a warning; a Stage 2 emergency requires service interruptions for some or all of selected customers, many of whom receive reduced rates as compensation for their agreement to be curtailed; a Stage 3 emergency requires involuntary curtailment of service—also referred to as rotating outages—to keep the system from collapsing.

- Reliability of the electric power system.
- Flexibility to diversify the mix of fuels that produces electricity by giving consumers access to an array of electricity sources.
- Cost structure of the entire industry by giving low-cost power plants access to high-cost power markets.
- Competition among electricity sources by giving more sources access to more markets, both near and far. (National Council on Electricity Policy 2004.)

California's electricity transmission system comprises more than 31,000 miles (50,251 kilometers) of bulk electric transmission lines and their supporting towers and substations. It links generation to load in a complex electrical network that balances supply and demand on a nearly instantaneous basis. In addition to the in-state transmission connections, California has a system of transmission interconnections that connect its electricity grid with out-of-state electricity generation; specifically, California is part of the Western Interconnection. With a total importing capacity of 18,170 MW[13], California's interconnections serve a critical role in satisfying California's electricity consumption. Figure 3.5-1 depicts the state's major transmission paths.

Transmission lines statewide are frequently running to their capacity limits, forcing system operators to reduce the output from less costly generation units, while keeping less efficient generators running to prevent the system from overloading. In other instances, transmission lines have had outages causing rolling blackouts. For example, a rolling blackout occurred in southern California in August 2005 when roughly one-half million customers had their power interrupted. The CEC has recommended a number of probable near-term transmission system upgrades[14] that mostly affect transmission interconnection for transmission-strapped southern California. (California Energy Commission 2005c.)

Mimicking the statewide transmission capacity limits, the Bay Area has consistently experienced transmission congestion for several years, with the peninsula having experienced a number of rolling blackouts. To alleviate the Bay Area's congestion problems, PG&E has recently completed the Jefferson–Martin 230- kV) Cable Project, a regional transmission line that imports electricity from near San Mateo into San Francisco, and the intracity (i.e., San Francisco) Potrero–Hunters Point 115-kV Cable. The utility also expects a second regional transmission cable (the Trans-Bay DC Cable, 400 MW— from Strategic Transmission Plan) and a second intracity transmission project (Hunters Point–Martin 115 kV Cable) to be completed in 2007. These projects would improve reliability and allow PG&E to retire older generation units, which would improve immediate transmission capacity limits in the Bay Area. (California Energy Commission 2005c.)

Electricity Demand and Generation Capacity Outlook

Extrapolating from the CEC's baseline prediction for statewide peak electricity demand in 2016, 2030's peak demand would be 82,880 MW[15] (California Energy Commission 2005d). Projections about generation capacity in 2030 are not possible because generation infrastructure decisions are

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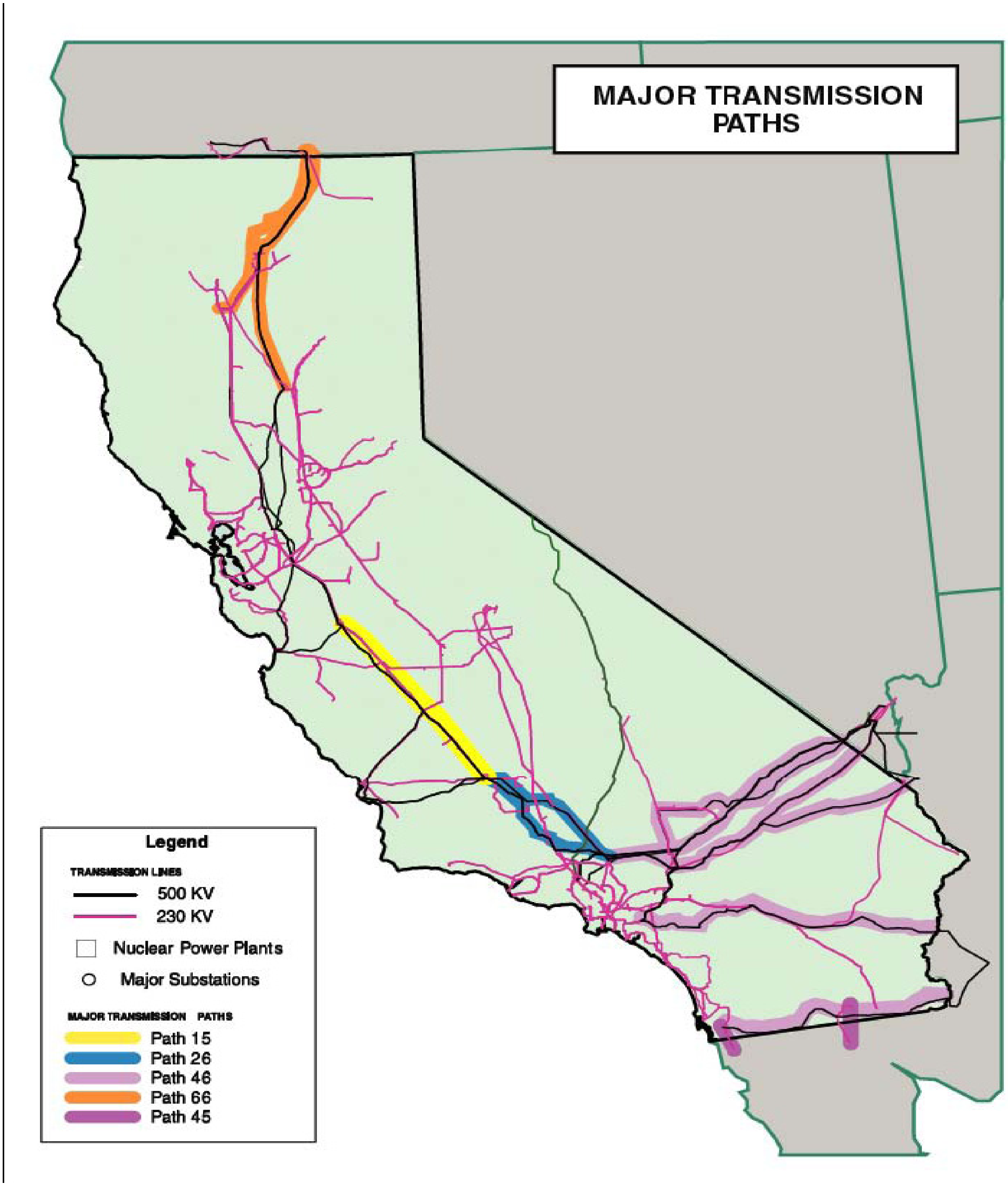
[13] Equivalent to approximately one-third of California's annual peak electricity demand

[14] Includes the Palo Verde -Devers No. 2 500 kV transmission project between Arizona and California and the Sunrise Powerlink 500 kV transmission project between the SDG&E and SCE service territories, both of which would reduce congestion on lines connecting, provide access to lower-cost generation, provide insurance against abnormal system conditions and power outages, and increase operating flexibility for California grid operators, reducing market power for generators and reducing the need for additional generation infrastructure. The latter would also provide interconnection to renewable resources located in the Imperial Valley. Two other near term projects, the Antelope Transmission Project and the Imperial Valley Transmission Project, would provide significant interconnection with wind projects in the Tahachapi Mountains and Imperial Valley, respectively.

[15] Based on the CEC's 2016 predictions and using the CEC's electricity demand growth estimates to extrapolate the 2016 prediction out to 2030. The low and high limits of the range of the forecasts are 70,486 and 74,465 MW, respectively.



Source: CEC, Systems Assessment & Facilities Siting Division, August 2005.

Figure 3.5-1
Major Transmission Paths
(230 to 500 kilovolt)

not generally made more than 2–3 years in advance of construction. Projections that are available run through 2010; recalling that the 2006 operating reserve during peak demand was 18.5%, the CEC projects that operating reserve margins in average-temperature years are projected to fall in the short term, reaching 16.5% by 2010, based on total net generation capacity of 71,263 MW and an average-temperature year demand of 62,995 MW. The CEC projections also include 2010 operating reserve margins of just 4.3%[16] in the case of adverse conditions, where demand response is realized and interruptible programs are used, or 0.4% where demand response is not realized and interruptible programs are not used, which would trigger a Stage 2 emergency in the former case and a Stage 3 in the latter. The CEC's finding about the reliability of California's electricity-generating resources is that generation is not keeping up with demand. The CEC states, "[c]onstruction of new power plants is not proceeding as planned, and the flow of new permit applications has noticeably decreased. California has more than 7,000 MW of permitted power plants that have not moved into construction. Adding to this, investor-owned utility (IOU) procurement focuses primarily upon near- and mid-term contracts, which perpetuates reliance upon the existing fleet of aging power plants." (California Energy Commission 2005b.)

Electricity Transmission Capacity Outlook

Historically, high-voltage transmission projects were planned and constructed to maintain reliability, connect a remote power plant to load centers, or provide access to a region with surplus generation. Future transmission projects would provide other strategic benefits, including insurance against contingencies, market power mitigation, fuel diversity, environmental benefits, and the meeting of state policy objectives, such as developing renewable resources and replacing or retiring power plants. Before the deregulation of the electricity industry in 1996, vertically integrated utilities made planning decisions on both generation and transmission projects. The utilities shared information about their generation plants and forecasts of power plant additions planned to meet their future loads. The utility would set a reliability objective and then select a combination of generation and transmission projects to achieve the reliability objective with minimum revenue requirement. Under a vertically integrated utility structure, integrated planning of generation and transmission was feasible. (California Energy Commission 2004b.)

Under the restructured electricity market, the integration between generation and transmission planning has changed. A lack of coordination between planning and decision-making for generation and transmission has resulted in transmission congestion because transmission infrastructure is not keeping pace with new generation facilities. As a result, as congestion and its associated costs go up, the expansion of transmission lines becomes economically justified. However, the price of power and the profit opportunities for generators are also affected by inefficient transmission expansion. (California Energy Commission 2004b.)

<u>Natural Gas</u>

California is the second largest consumer of natural gas in the nation, with consumption at more than 5.7 billion cubic feet (Bcf) (161 million cubic meters [Mcm]) per day in 2005. Approximately 42% of this total daily consumption was for electricity generation. Residential consumption accounts for 22%, followed by industrial, resource extraction, and commercial consumption. CEC's gas demand forecast projects continued growth at 0.07% annually through 2016, with volumes exceeding 6.1 Bcf (173 Mcm) daily by 2016, based on the 0.07% annual growth rate. (California Energy Commission 2006b.)

The total resource base (gas recoverable with today's technology) for the lower 48 states is estimated to be about 975 trillion cubic feet (Tcf) (28 trillion cubic meters [Tcm]), enough to continue current production levels for more than 50 years. Technology enhancements would continue to

[16] Based on high-temperature scenario demand of 66,797 MW.

enlarge this resource base; however, increases to production capacity are less certain (California Energy Commission 1999). Production in the continental United States is expected to increase from about 17 Tcf (0.48 Tcm) in 2005 base year to about 21 Tcf (0.59 Tcm) in 2030 (U.S. Department of Energy 2007). As of 2001, in-state natural gas production accounted for 15% of total consumption. Out-of-state production areas include the Southwest (38%), the Rocky Mountains (24%), and Canada (23%) (California Energy Commission 2006c).

California's Natural Gas Market Outlook

Although California's natural gas market is affected by nationwide price conditions, it has taken steps to insulate itself from the full magnitude of the price swing amplitudes. Since the height of the 2000-2001 energy crisis, California has built 2.2 Bcf (62.3 Mcm) of daily capacity to deliver natural gas supplies from Canada, the Rocky Mountains, and the Southwest, in addition to adding almost 1 Bcf (28 Mcm) of daily intrastate pipeline capacity. Utilities in California have also invested in underground storage capacity, an effective mechanism for controlling annual costs that will allow them to dampen the effect of future severe price increases by drawing on stored gas instead of buying high-priced natural gas on the open market. Since 2000-2001, California has added 38 Bcf (1.1 Bcm) of storage capacity, and, starting in 2003, users of those storage facilities have been placing natural gas into storage at record rates, and the state's inventory is at the high end of the 5-year average. Additional storage capacity additions are on-going. (California Energy Commission 2005b.)

The state of California has also provided utilities with the flexibility and tools to manage gas costs by purchasing natural gas supplies under different contract lengths and pricing terms and from a variety of supply sources. In addition, California is in the process of increasing its supplies of electricity from renewable power sources, such as wind, geothermal, and solar energy. California legislation enacted in 2002 (Senate Bill 1078) created the Renewable Portfolio Standard (RPS) Program, which requires retail sellers of electricity to increase their purchases of electricity generated by renewable sources, and establishes a goal of having 20% of California's electricity generated by renewable sources by 2017. Increasing California's renewable supplies will diminish the state's heavy dependence on natural gas as a fuel for electric power generation (California Energy Commission/California Public Utilities Commission 2003).

Relationship between Natural Gas and Electricity Resources in California

Increases in gas prices directly affect the price of electricity because of the large role that natural gas plays in electricity production throughout the Southwest—and in California in particular, where natural gas fueled 42.7% of electricity production in 2001. This percentage is likely to grow as the trend toward building natural gas power plants continues. During the spot-market price spike of February 2003, regional electricity prices rose 45% between early February 2003 and February 24, 2003, and an additional 150% between February 24 and February 26, 2003 (California Energy Commission/California Public Utilities Commission 2003). Such a dramatic price spike has not occurred since.

The functioning of the natural gas market, as well as the consequences of price changes in the natural gas market, is different from that of the electricity market. Unlike electricity, natural gas has the property of storability, which gives natural gas an advantage as a commodity over electricity. The storability of natural gas allows utilities to buy natural gas when prices are low and store it until prices rise, as well as price hedge in the futures markets, which mitigates short-term shortages. Long-term price increases are corrected by increases in production capacity, which are expected to bring prices down. Since the projected national in-the-ground natural gas reserves are expected to last for at least the next 50 years, actual supplies are not considered to be limiting, and short- and long-term prices are mostly a function of market conditions, assuming the trend toward improvements in natural gas production and transmission capacity continues (California Energy Commission/California Public Utilities Commission 2003).

Transportation Energy Consumption

Transportation accounts for a large portion of the California energy budget, with approximately 46% of the state's energy consumption resulting from the transport of goods and people. The population in California is projected to increase 28% by the year 2030. That growth equates to almost 10 million people (Cambridge Systematics 2007). Because of trends in travel demand, congestion, and other adverse travel conditions, the market for intercity travel in California that the proposed HST system could serve is projected to grow by up to 46% over the next 30 years.

Although travelers in, or who are visiting or leaving, the study area have several options for intercity travel—automobiles on interstate and state highways, commercial airlines, conventional passenger trains (Amtrak) on freight and/or commuter rail tracks, and long-distance commercial bus transit—the automobile is the predominant mode for intercity trips.

Transportation Energy Outlook

The recent fuel price increases have generated renewed interest in more fuel-efficient cars and in living closer to the workplace. Although it is a slow process to transform an automobile fleet, drivers are increasingly making automobile purchasing decisions based on fuel consumption concerns. Automobiles powered by diesel engines and engines that are hybrids composed of both electrical and gasoline components offer substantial fuel-efficiency upgrades over traditional gasoline engines.

Automobiles are most efficient when operating at steady speeds of 35–45 mph (56–72 kph) with no stops (U.S. Department of Energy 2006). Fuel consumption increases by about 30% when average speeds drop from 30 to 20 mph (48 to 32 kph), while a drop from 30 to 10 mph (48 to 16 kph) results in a 100% increase in fuel use with conventional automobile engines. Studies estimate that approximately 10% of all on-road fuel consumed is a result of congestion (California Energy Commission 1990).

As of 2005, 26 million automobiles were registered to drivers in California, which equated to the state being the second largest consumer of petroleum fuel in the world; only the United States consumes more. Because of this dependence on petroleum fuels, world geopolitical events can immediately and adversely affect the price and adequacy of California's fuel supply (California Energy Commission 2006e).

3.5.3 Environmental Consequences

A. NO PROJECT ALTERNATIVE

In 2000, passenger trips taken in California resulted in 354.9 billion automobile VMT (571.2 billion automobile VKT) and 75.8 million airplane VMT (122.8 million airplane VKT). By 2030, under the No Project Alternative, the total number of passenger trips estimated to be taken in California would result in about 416.7 billion automobile VMT (670.6 billion automobile VKT) and 131.9 million airplane VMT (213.9 million airplane VKT). The increase in passenger trips for is reflective of population growth expected over the same period.

Operational (Direct) Energy

As indicated in Table 3.5-3, the existing (Year 2000) energy used to power intrastate transportation was 2,002,140,708 million Btus (MMBtus), or 345 million barrels of oil. The 3.49 billion passenger trips estimated under the No Project Alternative would consume the equivalent of about 408 million barrels of oil. This is an increase of 63 million barrels of oil over existing conditions. On the one hand, this is a conservative estimate because, as noted in Section 3.5.3, automobile fuel efficiency decreases considerably as travel speed decreases below 30 mph (48 kph) and stop-and-go traffic increases. Because congestion levels under the No Project Alternative would likely be higher than they are under existing conditions, the increase in direct energy used in 2030 would have congestion-related cause to be higher than the estimated 63 million barrels. To illustrate this point, if the direct energy consumption factor for automobiles under a more congested No Project condition (increased by 5%, from 5,572 Btus/VMT to 5,851 Btus/VMT, and all other factors remained the same, the total direct energy consumption under the No Project Alternative would increase to 83 million barrels of oil, as opposed to 63 million barrels.

Key Findings

The No Project Alternative conditions would potentially place additional demand on statewide energy supplies compared to existing conditions as a result of increased passenger trips, higher levels of congestion, and slower speeds on intercity highways. There is some level of uncertainty because it is not clear how the energy intensity of the state's automobile fleet would change in the next 20 years.

Table 3.5-3
Annual Intercity Operational Energy Consumption in the Study Area

	2000 Existing[f]	2030 No Project Alternative[f]
Annual VMT (VKT) (millions)		
Auto[b]	354,878 (571,121)	416,681 (670,585)
Airplane[c]	76 (123)	132 (214)
HST[d]	0	0
Annual Energy Consumption (MMBtus)		
Auto	1,977,377,605	2,321,748,527
Airplane	24,763,102	43,128,553
HST	0	0
Total Energy Consumption (MMBtus[a])	2,002,140,708	2,364,877,081
Change in Total Energy from Existing (MMBtus[a])	—	362,736,373
Total Energy Consumption (Barrels of Oil[e]) (millions)	345	408
Change in Total Energy from Existing (Barrels of Oil[e]) (millions)	—	63

Notes:
[a] One Btu is the quantity of energy necessary to raise 1 pound of water 1° F.
[b] Based on 6/11/07 VMT/VHT data (Cambridge Systematics 2007).
[c] Based on airplane passengers flights (Cambridge Systematics 2007). Airplane VMT based on average number of passengers per flight: 101.25 (using 70% load factor per Business Plan).
[d] No HST is included in the existing conditions (2000) or No Project Alternative.
[e] One barrel of crude oil is equal to 5.8 MMBtus.
[f] Rounded.

Peak-Period Electricity Demand

The No Project Alternative electricity consumption would increase slightly over existing conditions resulting from programmed and funded projects and growth anticipated under the No Project Alternative. The possible future electrification of Caltrain, commuter rail systems, and/or Amtrak would also increase electricity use. While these projects would be regionally significant, they are small in scale compared to overall electricity usage and would be captured by routine electricity consumption forecasts by CEC, allowing electricity generation and transmission planning to account for and accommodate their additions.

Key Findings
CEC electricity supply capacity and demand projections account for the projected routine expansion increases of in the state's electricity requirements. Potential electricity demand under the No Project Alternative would be satisfied by expected expansion in generating capacity. No significant potential impacts on electricity generating capacity have been identified. *(Less than significant.)*

B. HIGH-SPEED TRAIN ALTERNATIVE

The HST Alternative would increase the transportation energy use in California with respect to existing conditions. However, compared to the No Project Alternative the HST Alternative would use less energy. As indicated in Table 3.5-4, energy use would decline by the equivalent of about 22 million barrels of oil when compared to the No Project Alternative. Additional energy savings over the No Project Alternative would be realized with implementation of the HST system because it would also ease congestion. The magnitude of the expected annual operational energy savings resulting from the HST system could also be lower than shown in Table 3.5-4 given the possibility of automobile fuel efficiency improvements.

Table 3.5-4
Annual Operational Energy Consumption in Study Area

	2000	**2030 Alternatives**	
	Existing	**No Project Alternative**[e]	**HST Alternative**
Annual VMT[b, c, g] (VKT) (millions)			
Auto[f]	354,878 (575,256)	416,681 (675,440)	389,903 (632,033)
Airplane[c]	76 (123)	132 (214)	73 (119)
HST	0	0	43 (70)
Annual Energy Consumption (MMBtus[a])			
Auto	1,977,377,605	2,321,748,527	2,172,540,142
Airplane	24,763,102	43,128,553	24,008,005
HST	0	0	39,707,950
Total Energy Consumption (MMBtus)	2,002,140,707	2,364,877,081	2,236,266,097
Change in Total Energy from Existing (MMBtus)		362,736,373	234,125,389
Change in Total Energy from No Project (MMBtus)	—	—	-128,610,984
Total Energy Consumption (Barrels of Oil[d]) (millions)	345	408	386
Change in Total Energy from Existing (Barrels of Oil[d]) (millions)	—	63	40
Change in Total Energy from No Project (Barrels of Oil[d]) (millions)	—	—	-22

	2000	2030 Alternatives	
	Existing	No Project Alternative[e]	HST Alternative

Notes:

[a] One Btu is the quantity of energy necessary to raise 1 pound of water 1°F.
[b] Based on airplane passengers flights (Cambridge Systematics 2007). Airplane VMT based on average number of passengers per flight: 101.25 (using 70% load factor per business plan HST VMT (California High-Speed Rail Authority 2000)
[c] Does not include airplane VMT resulting from passengers making connections to other flights to continue or complete their journey because these are a minor portion of the HST-served market.
[d] One barrel of crude oil is equal to 5.8 MMBtus.
[e] Fuel consumption for No Project would increase beyond the figures presented here as speeds drop below 30 mph on congested highways.
[f] Based on 6/11/07 VMT/VHT data (Cambridge Systematics 2007).

Energy intensities were calculated using passenger miles traveled (PMT)/passenger kilometers traveled (PKT) for each of the modes. Table 3.5-5 lists the energy intensity consumption factors of each of the modes. HST service would offer a sharp reduction in energy consumption per passenger mile (kilometer), compared to other modes, if actual ridership were to fall within the range of current projections and the planned operating plan were implemented. Specifically, whereas intercity trips taken in automobiles would average about 2,320 Btus/PMT (1,438 Btus/PKT) and those trips taken in airplanes would require 3,230 Btus/PMT (2,003 Btus/PKT), the HST system would require 975 Btus/PMT (605 Btus/PKT).

Table 3.5-5
Energy Consumption per Passenger Mile Traveled by Mode (PMT)

Mode	Energy Consumption[d]
Intercity Passenger Vehicles (auto, van, light truck)[a]	2,320 Btus/PMT (1,438 Btus/PKT)
Airplanes[b]	3,230 Btus/PMT (2,003 Btus/PKT)
High-Speed Train[c]	975 Btus/PMT (605 Btus/PKT)

Notes:
[a] Based on 2.4 passengers per vehicle.
[b] Based on 101.25 passengers per vehicle (70% load factor).
[c] Based on 994 passengers per 16-car trainset.
[d] Rounded.

Regional

In addition to the statewide direct automobile VMT savings that would result from travelers choosing HST travel, the proposed HST system would potentially provide additional regional VMT reductions, compared to the No Project Alternative conditions. Proposed HST station location options would be more numerous than airports, which would result in a lessening of the average distance required for passengers to travel from their points of origin to the mode transfer point (and vice versa) because of the likelihood that one or more of the stations would be closer to their point of origin than would their respective regional airport.

Key Findings

The comparison of the HST Alternative to the No Project Alternative shows that the proposed project would decrease energy use statewide by 22 million barrels of oil per year. (*Beneficial impact.*)

Peak-Period Electricity Demand

The electricity requirement of the HST Alternative operating schedule would be about 794 MW[17] during peak electricity demand periods in 2030. It is difficult to analyze how such potential load additions would affect the statewide electricity generation and transmission system. With respect to electricity surplus, as noted above, such a long time horizon has uncertainty, especially on the supply side, and capacity additions are difficult to predict more than 2 to 3 years into the future. The furthest out that the CEC currently provides generation and surplus projections is 2010. Whereas the operating reserve in 2006 was 18.5%, the projected 2010 operating reserve is 16.5% during average temperature conditions[18]. To illustrate how the addition of the HST Alternative would affect the state's electricity grid in 2010, were it hypothetically completely operational by then, the HST operating plans would add enough load to bring the operating reserve down to 9.0%, all else being equal. This is only hypothetical, and it is expected that by the time the HST system were to become operational, the entire system would be larger and the amount by which the HST load would cause the operating reserve to decline would be smaller.

Another way to understand how the additional load would affect the statewide electricity system is to compare the expected load caused by the addition of the HST system to the projected demand in the build year (2030) because prediction horizons for demand estimates are longer than for capacity additions, as noted. The additional 794-MW load that would be placed on statewide electricity generating resources by the HST system would represent approximately 0.96% of the 2016 CEC-predicted statewide electricity demand extrapolated to 2030.[19] When viewed in the context of California's entire electricity system, with the percentage of demand acting as a conceptual surrogate for supply capacity, the additional load that the HST system would place on the system is not significant. Moreover, the HST system would be built and become operational in stages, which would allow the system to gradually increase its electricity consumption rate to 794 MW instead of placing the entire load on the state's production and transmission resources abruptly. The gradual increase would allow the in-state and out-of-state electricity generation and transmission industries and planners to anticipate and respond to the effects of the proposed HST system on generating and transmitting resources.

Regional

Regional impacts on the electricity grid could occur if the proposed HST system contributed to electricity transmission deficiencies, or bottlenecks, which were described in Section 3.5.2. If bottlenecks were to be aggravated by the HST system, a potentially significant impact could result. Through careful electrification design (i.e., design the system so that it draws power from the electricity grid at several places throughout the state), it would be possible to minimize or eliminate such potential problems. Also, bottlenecks in the current grid system are being addressed. If planning transmission line capacity continues to grow to anticipate statewide needs, the HST system would not have the potential to cause a significant impact on transmission.

Key Findings

The HST Alternative could cause potentially significant impacts on the state's electricity grid if the generation and transmission capacity were not equipped to handle the additional load. However, the HST system would represent a small percentage of the generating and transmission capacity required to satisfy projected overall demand. Staggering the completion of construction and the start of major

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17 Based on an average electricity use of 74.2 kW/train mi, which equates to an average electricity use rate of the order of 12 MW per trainset when integrated over 1 hour. These are averages and do not reflect acceleration or changes in grade; they are for planning purposes only.

18 So-called adverse conditions would result in a 4.3% during higher than average temperature conditions if demand response and interruptibles are realized and implemented, respectively.

19 This is consistent with the results identified in the Statewide Program EIR/EIS, which was estimated for 2020. The analysis for this Program EIR/EIS was for 2030.

operations would make the load additions less abrupt than would be the case if the start of the full planned operations were to occur simultaneously.

C. HST CONSTRUCTION (INDIRECT) ENERGY

Construction of the programmed and funded transportation improvements under the No Project Alternative would require less energy than construction of the HST system.

Project Construction

The HST system construction-related energy consumption would result in a one-time, non-recoverable energy cost, which would occur during construction of on-the-ground, underground, and aerial facilities such as trackwork, guideways, structures, maintenance yards, stations, and support facilities. Details regarding energy conservation practices have not been specified for the HST system, which has not been designed in detail, nor have construction methods and staging been planned at this time. Given the scope and scale of the improvements proposed as part of the HST system, however, it is anticipated that the construction-related energy requirement would be substantial. Table 3.5-6 shows estimates of potential construction-related indirect energy consumption for the statewide HST system.

Table 3.5-6
Non-Recoverable Construction-Related Energy Consumption

Structure	Rural vs. Urban[a]	Facility Quantity[b]	Energy Consumption[c] (MMBtus)
HST guideway (at grade)	Rural	2,074 guideway mi (3,361 km)	25,485,000
	Urban	619 (1,003 km)	11,829,000
HST guideway (elevated)	Rural	271 guideway mi (439 km)	15,026,000
	Urban	153 (249 km)	8,529,000
HST guideway (below grade, cut)	Rural	30 guideway mi (497 km)	3,557,000
	Urban	70 (114 km)	11,469,000
HST guideway (below grade, tunnel)	Rural	128 guideway mi (208 km)	15,034,000
	Urban	110 (178 km)	35,966,000
HST station	N/A	23 stations	1,794,000
HST Total			128,688,000

[a] Assumes the HST would be constructed in rural and urban areas at the following proportions:
- Bay Area to Central Valley: Rural (40%), Urban (60%)
- Sacramento to Bakersfield: Rural (95%), Urban (5%)
- Bakersfield to Los Angeles: Rural (70%), Urban (30%)
- LOSSAN: Rural (30%), Urban (70%)
- Los Angeles to San Diego via Inland Empire: Rural (60%), Urban (40%)

[b] Measured in guideway miles for non-discrete structures (e.g., highways and HST guideways), and in structure quantities for discrete structures (e.g., HST stations).

[c] Rounded.

As shown in the table, the construction of the proposed HST Alternative (statewide) would consume 128,688,000 Btus, or about 22 million barrels of oil. Energy savings resulting from operation of the HST Alternative would repay the construction energy consumption in about 1 year.

Secondary Facilities

It is reasonable to assume that secondary facilities, such as those used in the production of cement, steel, and so on, would employ all reasonable energy conservation practices in the interest of minimizing the cost of doing business. Therefore, it can reasonably be assumed that construction-related energy consumption by secondary facilities would not consume nonrenewable energy resources in a wasteful, inefficient, or unnecessary manner under either HST Alternative.

Construction of the HST Alternative is anticipated to take a number of years. Construction would occur in stages, and some segments would be open for operation while others are still under construction. Given the scope and scale of the HST system, it is anticipated that secondary construction-related energy requirements would be substantial.

Due to the scope and scale of the improvements proposed as part of the HST system, construction-related energy impacts, both project and secondary, would be potentially significant. Construction of the HST Alternative would potentially represent a significant use of nonrenewable resources.

3.5.4 Role of Design Practices in Avoiding and Minimizing Effects

The selected electrically powered HST technology is energy efficient, requiring substantially less energy than other modes of intercity travel. Implementation of the HST Alternative throughout the state is anticipated to reduce energy use over the No Project Alternative.

This is a broad program-level analysis reviewing potential statewide energy use and impacts related to the proposed HST Alternative. The HST system would be designed to minimize electricity consumption. The design particulars would be developed at the project level of analysis, but would include the following:

- Use regenerative braking to reduce energy consumption of the system.
- Minimize grade changes in steep terrain areas to reduce the use of electricity during peak periods.
- Use energy-saving equipment and facilities to reduce electricity demand.
- Maximize intermodal transit connections to reduce automobile VMT (VKT) related to the HST system.
- Develop and implement a construction energy conservation plan.
- Develop potential measures to reduce energy consumption during operation and maintenance activities.

3.5.5 Mitigation Strategies and CEQA Significance Conclusions

Based on the analysis above, and considering the discussion in CEQA Appendix F on energy conservation, the HST Alternative would have a potentially significant impact related to long-term electric power consumption when viewed on a systemwide basis. It is calculated that the statewide HST system would increase the projected statewide electricity demand by approximately 0.96% in 2030. The electricity demand is consistent with what was identified for the statewide HST system in the Statewide Program EIR/EIS. Although the HST system would result in an increase in electricity demand, it also represents a mode of transportation that is more energy efficient than travel by automobile. The HST system would result in an overall reduction in total energy consumption (combined electric power demand and oil consumption). The following mitigation strategy as well as the design practices discussed in Section 3.5.4 would be applied to further reduce operational energy consumption and can be refined and applied at the project-level.

- Locate HST maintenance and storage facilities within proximity to major stations/termini.

Construction of the HST Alternative would result in one-time non-recoverable energy consumption costs in addition to energy consumed by the planned transportation improvements included in the No Project Alternative. The result of the construction of the HST Alternative would be a new transportation mode that would reduce fuel consumption as compared to the 2030 No Project Alternative. At the program level this impact is considered significant due to the uncertainty of future projections of energy demand and generation capacity to 2030. The following mitigation strategies can be refined and applied at the project-level to reduce this impact:

- Develop and implement a construction energy conservation plan.
- Use energy efficient construction equipment and vehicles.
- Locate construction material production facilities on-site or in proximity to project construction sites.
- Develop and implement a program encouraging construction workers to carpool or use public transportation for travel to and from construction sites.

The above mitigation strategies are expected to reduce the short-term and long-term electric power consumption impacts of the HST system to a less-than-significant level. Additional environmental assessment would allow a more precise evaluation in the second-tier, project-level environmental analyses.

3.5.6 Subsequent Analysis

Subsequent energy analysis would be required in a project-level environmental document. Detailed analysis of base and peak-period electricity requirements and transmission infrastructure would be required to more precisely assess the adequacy of electricity generation and transmission capacity relative to demand for each alignment alternative to be pursued. Comprehensive traffic analysis for future conditions would be required to assess regional energy impacts in more detail for each segment.

Subsequent energy analysis at the project level would follow the methodology applied in this evaluation but would employ more detailed traffic and electrical input data for the energy consumption analysis. Energy consumption factors would be updated using the latest available published information. Detailed construction staging, sequencing, methods, and practices would be necessary to support a quantitative analysis of construction energy consumption.